REMARKS

Claims 1 through 12 are pending in this application. The specification has been amended to address grammatical issues and claims 1 through 12 amended. Care has been exercised to avoid the introduction of new matter. Adequate description support for the present Amendment should be apparent throughout the originally filed disclosure as, for example, the disclosed embodiments and related discussion thereof in the written description of the specification. Applicants would note that the claim amendments primarily address grammatical issues and clarify that the embodiments of the present invention can comprise one or more partitions, each of which partition can comprise one or more plates, as can be appreciated from the depicted embodiments, notably Figs. 1 through 5. Applicants submit that the present Amendment does not generate any new matter issue.

A clean copy of the paragraph in the specification affected by the present Amendment and of amended claims 1 through 12 appear in the Appendix hereto.

Objection to the Drawing

The Examiner asserted that Figs. 8 through 10 should be designed by the legend, such as --PRIOR ART--. In response, it is proposed to amend interface 8 through 10 by providing the legend, --PRIOR ART--, as indicated in red on the attached photocopies. A Formal Request for Approval of Drawing Amendment submitted currently herewith.

The Examiner also objected to the drawings pursuant to 37 C.F.R. §1.83(a), asserting the features of claims 6, 10 and 11 are not depicted. In response, claims 6, 10 and 11 have been amended to address the issues identified by the Examiner, thereby

overcoming the stated basis for the objection to the drawings pursuant 37 C.F.R. §1.83(a). Withdrawal of the drawing objection is, therefore, solicited.

Claims 1 through 12 have been rejected under the second paragraph of 35 U.S.C. §112. This rejection is traversed.

Claims 1 through 12 have been amended to address the issues raised by the Examiner by reciting the presence of one or more partitions, each partition comprising one or two separating plates, as should be apparent from the depicted embodiments, notably Figs. 1 through 5.

Applicants submit that one having ordinary skill in the art would have no difficulty understanding the scope of the now claimed invention, particularly when reasonably interpreted in light of and consistent with the written description of the specification, which is the judicial standard. *Miles Laboratories, Inc. v. Shandon, Inc., 997 F.2d 870, 27 USPQ2d 1123 (Fed. Cir. 1993).* Applicants, therefore, submit that the imposed rejection of claims 1 through 12 under the second paragraph of 35 U.S.C. §112 is not viable and, hence, solicit withdrawal thereof.

Claims 1, 2, 4, 5 and 7 through 10 were rejected under 35 U.S.C. §103 for obviousness predicated upon Kobayashi.

This rejection is traversed.

Improper Reliance Upon Kobayashi

The Honorable Board of Patent Appeals and Inteferences has held that where the Examiner relies upon the abstract of a foreign language document, the Examiner must provide an English language translation of that document. *Ex parte Gavin, 62 USPQ2d 1680 (BPAI 2001); Ex parte Jones, 62 USPQ2d 1206 (BPAI 2001).* Accordingly, the Examiner's reliance upon Kobayashi without providing the English language translation is improper.

At any rate, in order not to unnecessarily delay prosecution of this application, Applicants have undertaken the expense of providing a partial English language translation of the relevant portions of Kobayashi which is appended hereto as Exhibit A. For reasons which should be apparent, based upon the English language translation of Kobayashi, and insufficient factual basis exist upon which to deny patentability to the claimed invention under 35 U.S.C. §103.

Insufficient Facts

It should be apparent from Exhibit A, that the first example disclosed by Kobayashi relates to the apparatus depicted in Figs. 1 through 4. Fig. 3 shows the drawing step. The Examiner interpreted element 13 together with 15 as the muffle tube. The Examiner apparently would further determine that elements 21 and 22 constitute the inner tube. Lid 26 is positioned on top of 13. Nitrogen gas is then introduced into drawing chamber A from a glass-blowing inlet (not shown) of furnace body 12.

However, in accordance with the present invention, one or more partitions, each partition comprising one or two separating plates, separate a space inside the inner tube above said preform into plural parts in an advancing direction of the preform **and descending with the preform during drawing an optical fiber**. This feature is neither disclosed nor suggested by Kobayashi.

In order to underscore the differences between the claimed invention and Kobayashi's furnace, Applicants would note that Fig. 3 of Kobayashi shows the drawing step. In comparing Kobayashi's Fig. 3 with Figs. 1, 2A, 2B, 7A and 7B of the present invention, element 13 together with element 15 can be considered to correspond to "the muffled tube and the inner tube", while element 26 can be said to correspond to the upper lid of the present invention. It should be apparent that Kobayashi neither discloses nor suggests a partition that moves downward with a preform during the drawing step. This difference between the claimed invention and Kobayashi is functionally significant in that the space above the preform can be narrowly limited with movable partitions, and the circular heating motion is restricted, thereby suppressing a fluctuation in the outer diameter of the optical fiber.

For clarification, Applicants would note that in the English language translation of Kobayashi, "lid 25" in paragraph [0019] it should be "lid 26"; whereas, "lid 26" in line 15 should be "lid 25." These are mistakes in the original Japanese specification.

The above argued differences between the claimed invention and Kobayashi's furnace undermine the obviousness conclusion under 35 U.S.C. §103. Indeed, it is not apparent wherein resides any factual basis upon which to predicate the conclusion that one having ordinary skill in the art would have been realistically impelled to modify

Kobayashi's apparatus to arrive at the claimed invention. *In re Lee __F.3d__, 61 USPQ2d 1430, 14333 (Fed. Cir. 2002).*

Applicants separately argue the patentability of claim 7 which requires protrusions on the outer periphery of the separating plate. This is not a method limitation. Protrusions on a separating plate are structural limitations. The Examiner has provided no factual basis upon which to predicate the conclusion that one having ordinary skill in the art would have been realistically motivated to modify Kobayashi's device by providing protrusions as in the claimed invention. *In re Lee, supra.*

Applicants separately argue the patentability of claim 10. The Examiner's rejection is, firstly, without any factual basis. *In re Lee, supra.* Further, the Examiner has not provided any factual basis upon which to predicate the conclusion that one having ordinary skill in the art operating Kobayashi's furnace would have been cold enough to provide an additional furnace in the vicinity of the upper end of the inner tube to heat the upper space inside the inner tube, not workers spaced apart from Kobayashi's furnace. *In re Jones, supra.*

Based upon the foregoing, Applicants submit that the imposed rejection of claims 1, 2, 4, 5 and 7 through 10 under 35 U.S.C. §103 for obviousness predicated upon Kobayashi is not factually or legally viable and, hence, solicit withdrawal thereof.

Claims 11 and 12 were rejected under 35 U.S.C. §103 for obviousness predicated upon Saito et al.

This rejection is traversed.

The present invention is entitled to the priority dates of Japanese Patent Application No. H10/219515 which is August 4, 1998 and Japanese Patent Application No. H10/257683 which is September 11, 1998, each of which antedates the October 20, 1998 filing of Saito et al. Submitted herewith are English language translations of the relied upon Japanese Patent Applications (Exhibit B) to overcome the filing date of Saito et al., thereby overcoming the imposed rejection of claims 11 and 12 under 35 U.S.C. §103.

Applicants, therefore, submit that the imposed rejection of claims 11 and 12 under 35 U.S.C. §103 for obviousness predicated upon Saito et al. is not viable and, hence, solicit withdrawal thereof.

Applicants acknowledge, with appreciation, the Examiner's indication that claims 3 and 6 would be allowed upon overcoming the imposed rejection under the second paragraph of 35 U.S.C. §112 and placed in independent form. It should be apparent from the foregoing, that the imposed objections and rejections have been overcome and, hence, that all pending claims are in condition for immediate allowance. Favorable consideration, therefore, respectfully solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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APPENDIX

The paragraph beginning at page 2 now read as follows.

Marked-up

The gas passage 24a is formed between the inner tube 22 and the outer tube 23 arranged outside the same, and an inert gas is supplied from the gas supplying inlet 24 to the gas passage 24a, so as to blow the inert gas into the inside of the inner tube 22 from the [numeral] numerous gas blowing inlets 22a provided circumferentially and in the height direction on the wall surface of the inner tube 22. The inert gas is flowed inside the inner tube 22 and the muffle tube 28 to prevent oxidation deterioration of the muffle tube and the like, and when the temperature distribution of the inert gas by heating and the flow of the inert as are not uniform, [the] fluctuation of the diameter of the optical fiber drawn from the preform is liable to occur.

IN THE CLAIMS:

Claims 1 through 12 now read as follows.

1. (Amended) A furnace for drawing an optical fiber comprising a muffle tube and an inner tube connected to an end of the muffle tube, arranging inside said muffle tube and said inner tube a preform supported by a dummy rod at an upper part thereof, in such a manner that said preform descends with said dummy rod and said preform is melted by a heater arranged outside of said muffle tube, so as to draw an optical fiber from the lower end of said preform, wherein one or more partitions, each partition comprising one or two separating plates, separate a space inside said inner tube above said preform into plural parts in an advancing direction of said preform arranged inside said space, and descending with said preform during drawing an optical fiber, and

09/622,827

APPENDIX

The paragraph beginning at page 2 now read as follows.

sub C1 B1

The gas passage 24a is formed between the inner tube 22 and the outer tube 23 arranged outside the same, and an inert gas is supplied from the gas supplying inlet 24 to the gas passage 24a, so as to blow the inert gas into the inside of the inner tube 22 from the numerous gas blowing inlets 22a provided circumferentially and in the height direction on the wall surface of the inner tube 22. The inert gas is flowed inside the inner tube 22 and the muffle tube 28 to prevent oxidation deterioration of the muffle tube and the like, and when the temperature distribution of the inert gas by heating and the flow of the inert as are not uniform, fluctuation of the diameter of the optical fiber drawn from the preform is liable to occur.

IN THE CLAIMS:

Claims 1 through 12 now read as follows.

sub C2 B2

1. (Amended) A furnace for drawing an optical fiber comprising a muffle tube and an inner tube connected to an end of the muffle tube, arranging inside said muffle tube and said inner tube a preform supported by a dummy rod at an upper part thereof, in such a manner that said preform descends with said dummy rod and said preform is melted by a heater arranged outside of said muffle tube, so as to draw an optical fiber from the lower end of said preform, wherein one or more partitions, each partition comprising one or two separating plates, separate a space inside said inner tube above said preform into plural parts in an advancing direction of said preform arranged inside said space, and descending with said preform during drawing an optical fiber, and

a gas blowing inlet for blowing an inert gas into said inner tube and said muffle tube is provided at the wall of said inner tube at a part under said separating plate.

2. (Amended) A furnace for drawing an optical fiber as claimed in claim 1, comprising two or more partitions, wherein the separating plates being penetrated by said dummy rod descend with said dummy rod, and said respective plural partitions of separating plates are stopped one by one on said inner wall of said inner tube from an upper part, as that said space inside said inner tube above said preform is separated into an upper part and a lower part by each said stopped separating plate.

B2

3. (Amended) A furnace for drawing an optical fiber as claimed in claim 2, wherein the outer diameters of said respective separating plates of the two or more partitions decrease gradually one by one from the upper part to the lower part, said inner tube has a truncated cone shape by decreasing the inner diameter thereof from the upper part to the lower part, said plural partitions of separating plates descend with said dummy rod, and said plural partitions of separating plates are stopped in their descent one partition by one partition from the upper part owing to the contact of the outer periphery of said separating plate with the inner wall of said inner tube.

4. (Amended) A furnace for drawing an optical fiber as claimed in claim 2, wherein at least one of said plural partitions is composed of an outer member and an inner member, an outer diameter of said outer member is the same as the inner diameter of said inner tube at a position where said outer member is stopped by said inner tube, the

center hole diameter of said outer member is larger than the outer diameter of said dummy rod so as to absorb the deviation from a concentric condition of said inner tube and said dummy rod, the outer diameter of said inner member is larger than said center hole diameter of said outer member and is smaller than said outer diameter of said outer member, the center hole diameter of said inner member is larger than said outer diameter of said dummy rod, and said dummy rod penetrates through said center holes while said outer member is placed at the lower side and said inner member is placed at the upper side, so as to support said inner member by said outer member when said outer member of said separating plate is stopped by said inner wall of said inner tube.

B2

5. (Amended) A furnace for drawing an optical fiber as claimed in claim 1, characterized in that said one partition or plural partitions, each partition comprising one or two separating plates, arranged in the vicinity of the lower end of said dummy rod or the upper part of said preform to descend with said preform.

6. (Amended) A furnace for drawing an optical fiber as claimed in claim 5, wherein at least one of said one partition or plural partitions is composed of an outer member and an inner member, the outer diameter of said outer member is smaller than the inner diameter of said inner tube, the center hole diameter of said outer member is larger than the outer diameter of said dummy rod so as to absorb the deviation from a concentric condition of said inner tube and said dummy rod, the outer diameter of said inner member is larger than said center hole diameter of said outer member and smaller than said outer diameter of said outer member, the center hole diameter of said inner

member is the same as or larger than said outer diameter of said dummy rod, and said dummy rod penetrates through said center hole while said inner member is fixed to said dummy rod or is placed on a supporting member fixed to said dummy rod, and said outer member is placed on said inner member.

7. (Amended) A furnace for drawing an optical fiber as claimed in claim 1, wherein each separating plate has plural protrusions provided on the outer periphery of the separating plate, so as to prevent parts of said separating plate other than said protrusions from contacting said inner wall surface of said inner tube.

B2

8. (Amended) A furnace for drawing an optical fiber as claimed in claim 1, wherein each said separating plate comprises a heat insulating material.

9. (Amended) A furnace for drawing an optical fiber as claimed in claim 8, wherein each said separating plate comprises a heat insulating material formed of carbon felt.

10. (Amended) A furnace for drawing an optical fiber as claimed in claim 1, further comprising an auxiliary heater arranged in the vicinity of an upper end of said inner tube, so as to heat an upper space inside said inner tube.

11. (Amended) A method for drawing an optical fiber comprising: arranging a preform supported by a dummy rod at an upper part of the preform inside a muffle tube

and an inner tube connected to an end of the muffle tube in such a manner that said preform descends with said dummy rod, and melting said preform by heating to draw an optical fiber form said preform, such that while one partition or plural partitions of separating plates are arranged inside said inner tube to vertically separate a space inside said inner tube into plural parts, the vicinity of the lower end of said preform is melted while an inert gas flows into the inside of said inner tube and a muffle tube via a gas blowing inlet provided on a wall of said inner tube under said separating plate, so as to draw an optical fiber from a lower end of said preform.

B2

12. (Amended) A method for drawing an optical fiber as claimed in claim 11, wherein while a vertical temperature difference in an upper space inside said inner tube is reduced by heating a vicinity of an upper end of said upper space inside said inner tube by an auxiliary heater, said vicinity of said lower end of said preform is heated and melted by a heater arranged outside said muffle tube, so as to draw an optical fiber from said lower end of said preform.

EXHIBIT A

Japanese Patent Laid-Open No. 199536/1994

[Embodiments]

Embodiments according to the invention will be described below in detail with reference to the drawings.

[0017]

Fig. 1 schematically shows a furnace for drawing an optical fiber, according to an embodiment of the invention, and Figs. 2 to 4 schematically show a process of drawing an optical fiber in the furnace for drawing an optical fiber.

[0018]

As shown in Fig. 1, in a furnace 11 for drawing an optical fiber, according to the embodiment, an inlet 13 and an outlet 14 are formed on a cylindrical-shaped furnace body 12, a muffle tube 15 formed of carbon is arranged in the furnace, and a heater 16 is mounted about an outer periphery of the carbon muffle tube 15. An openable shutter 17 is mounted at the inlet 13 of the furnace body 12 while an openable lid 18 having a small hole is mounted to the outlet 14. Thus a drawing chamber A is defined in the drawing furnace 11. Also, connected to the furnace body 12 are CO-O_2 concentration meters 19, 20 for detecting changes in concentrations of carbon monoxide (CO) or carbon dioxide (CO_2) and oxygen (O_2) in the drawing chamber A. In addition, the surrounding of the furnace body 12 is of water-cooled structure (not shown) Also, inert gas jet ports (not shown) are formed uniformly circumferentially on an upper wall surface

of the furnace body 12 to permit an inert gas to continuously flow into the drawing chamber A.

[0019]

A pair of cylindrical-shaped frame bodies 21, 22 for defining a storage chamber B are provided above the furnace body 12 to be able to assmble or disassemble each other and to be opened and closed by a plurality of air cylinders 23. The storage chamber B in such frame bodies 21, 22 and the drawing chamber A in the furnace body 12 are capable of communicating to each other, such communicating and shutting-off operations being carried out by the shutter 17, and a through hole 24 is formed on upper portions of the frame bodies 21, 22 to permit insertion therethrough of a support rod 42, on a tip end of which an optical fiber preform 41 is held. Further, mounted to the support rod 42 are a lid 25, which serves to close the inlet 13 of the furnace body 12 to maintain the drawing chamber A in a gas-tight state, and a lid 26, which serves to close the through hole 24 on the upper portions of the frame bodies 21, 22 to maintain the storage chamber B in a gas-tight state.

[0020]

Also, formed on the frame bodies 21, 22 are a plurality of supply ports 27, through which nitrogen gas (N_2) as an inert gas is supplied into the storage chamber B, and a discharge port 28, through which carbon monoxide, oxygen or the like in the storage chamber B is discharged, the supply ports 27 being

connected to a N_2 gas supply system 29, and the discharge port 28 having a check valve (not shown) mounted thereto. In addition, the surroundings of the frame bodies 21, 22 are also of water-cooled structure (not shown) like the furnace body 12.

[0021]

Thus, when such furnace 11 is used to perform an optical fiber drawing operation, the shutter 17 is first closed as shown in Fig. 1 to shut off the drawing chamber A in a closed state, and nitrogen gas is permitted to continuously flow into the drawing chamber A from the gas jet port in the furnace body 12. Meanwhile, the optical fiber preform 41 held on the support rod 42 is caused to descend, and the respective air cylinders 23 are actuated to have the pair of frame bodies 21, 22 approaching and coming into close contact with each other, whereby the frame bodies 21, 22 store the optical fiber preform 41 in the storage chamber B as shown in Fig. 2. And the gas supply system 29 supplies and fills nitrogen gas into the storage chamber B from the respective supply ports 27 while unnecessary carbon monoxide and oxygen are discharged from the discharge port 28 to put the storage chamber B in a clean state of high level.

[0022]

From such state, when the shutter 17 is opened to provide communication between the drawing chamber A and the storage chamber B and to permit the optical fiber preform 41 to descend to be inserted into the drawing chamber A, the optical fiber

preform 41 is held at a predetermined position in the drawing chamber A as shown in Fig. 3 and the inlet 13 of the furnace body 12 is closed by the lid 26 to put the drawing chamber A in a closed state. At this time, the two $CO-O_2$ concentration meters 19, 20 are used to measure changes in concentrations of carbon monoxide (or carbon dioxide) and oxygen in the drawing chamber A and to detect whether unnecessary gas or the like has entered at the time of communication between the drawing chamber A and the storage chamber B. More specifically, the optical fiber preform 41 has been heated to 2000 degrees or higher in the furnace body 12 by the heater 16, during which various gases, dust or the like will be generated to adhere to surfaces of the optical fiber preform 41 to cause damage to surfaces of an optical fiber 43 to significantly decrease strength thereof. Therefore, when changes in concentration are detected by the concentration meters 19, 20, that is, concentration is increased due to entry of carbon monoxide (or carbon dioxide) and oxygen, a flow rate of nitrogen gas flowing into the drawing chamber A from the gas jet port in the furnace body 12 is controlled to maintain a clean state of high level.

[0023]

Then the heater 16 softens and melts the optical fiber preform 41, thus permitting a lower end of the preform to be drawn to make an optical fiber 43.

[0024]

Hereupon, on-line control is continuausly performed in the drawing operation of an optical fiber 43 by using the two $CO-O_2$ concentration meters 19 and 20 to detect changes in concentrations of carbon monoxide (or carbon dioxide) and oxygen in the drawing chamber A. That is, even when nitrogen gas is caused to continuously flow into the drawing chamber A, carbon monoxide and oxygen cannot be completely removed, and they are somewhat remained therein. In the drawing operation of an optical fiber 43, a ratio of changes in concentrations of carbon monoxide and oxygen remaining in the drawing chamber A is investigated relative to temperature changes in the furnace body (the drawing chamber A) 12. Then when an interior of the drawing chamber A is at around 500 degrees, oxygen is high in concentration and carbon monoxide is very low in concentration. When the interior of the drawing chamber A is heated to be increased in temperature, oxygen decreases in concentration while carbon monoxide rises in concentration. When the interior of the drawing chamber A becomes at 2000 degrees or higher, oxygen is low in concentration and carbon monoxide becomes very high in concentration.

[0025]

In the drawing operation of an optical fiber 43, when the furnace body (the drawing chamber A) 12 is heated to high temperatures, the following reaction occurs because of the muffle tube 15 being formed of carbon.

[Chemical formula 1]

$2O_2 + 3C \rightarrow 2CO + CO_2$

[0026]

That is, carbon (C) of the muffle tube 15 reacts with oxygen (O_2) remaining in the drawing chamber A whereby carbon monoxide (CO) or carbon dioxide (CO_2) is generated. Accordingly, while oxygen decreases in concentration due to temperature rise in the drawing chamber A, carbon monoxide increases in concentration. In the embodiment, the interior of the drawing chamber A is maintained in a clean state of high level by using the CO-O_2 concentration meters 19, 20 to detect changes in concentrations of carbon monoxide and oxygen in the drawing operation of an optical fiber 43. Concretely, the CO-O_2 concentration meters 19, 20 are used to measure concentrations of oxygen and carbon monoxide with temperature rise in the drawing chamber A, and when a decrease in concentration of oxygen and an increase in concentration of carbon monoxide are detected, nitrogen gas as an inert gas is caused to continuously flow into the drawing chamber A, whereby the increased carbon monoxide is discharged.

[0027]

Hereupon, in the case where an optical fiber 43 becomes below standards of glass structure and transmission characteristics in the drawing operation of the optical fiber 43, it is necessary to suspend the drawing operation, draw up

and take out an optical fiber preform 41 from the furnace 11, charge another optical fiber preform into the furnace 11 and to resume the drawing operation. In this case, the optical fiber preform 41 in the drawing chamber A is drawn up in a reverse manner to the above, and returned into the storage chamber B defined by the frame bodies 21, 22 as shown in Fig. 2, and the shutter 17 is closed. Then the frame bodies 21, 22 are moved upward together with the optical fiber preform 41 stored therein as shown in Fig. 4, and opened at their lower portions. In this state, the gas supply system 29 supplies nitrogen gas into the storage chamber B through the respective supply ports 27 to forcedly cool the optical fiber preform 41 thus heated. Then cooling can be effected in substantially 20 to 30 minutes. And the respective air cylinders 23 are actuated to separate the pair of frame bodies 21, 22 from each other for opening, and the optical fiber preform 41 having been cooled to room temperature is drawn up to be taken out.

[0028]

In this manner, with the drawing furnace 11 according to the embodiment, the frame bodies 21, 22 for storage of an optical fiber preform 41 are divided into two halves and provided to be capable of being opened and closed by the air cylinders 23, so that even a large-sized optical fiber preform 41 can be adequately stored, which eliminates the need of making the storage chamber B (the frame bodies 21, 22) large-sized and

achieves space saving. Also, before and during the drawing operation of an optical fiber 43, the CO-O_2 concentration meters 19, 20 are used to detect changes in concentrations of carbon monoxide (or carbon dioxide) and oxygen in the drawing chamber A, and so it is possible to maintain an interior of the drawing chamber A in a clean state of high level. Further, in an operation, in which an optical fiber preform 41 is taken out, the operation can be performed in a short period of time since the optical fiber preform 41 in the drawing chamber A is stored in the storage chamber B defined by the frame bodies 21, 22, where the gas supply system 29 supplies nitrogen gas to forcedly cool the optical fiber preform 41 thus heated.

EXHIBIT B

[Document Name]	: Patent Application
[Reference Number]	: 098Y0279
[Destination]	: To the Commissioner of the JPO
[International Patent Class]	: C02B 37/029 G02B 6/00 356
[Title of the Invention]	: FURNACE AND METHOD FOR OPTICAL FIBER WIRE DRAWING
[Number of Claims]	: 8
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[Priority Claimed]	
[Application Number]	: Japanese Patent Application No. 10-090520
[Filing Date]	: April 3, 1998
[Accounting Way]	: Prepaid
[Deposit Number]	: 008224
[Fee]	: 21,000YEN
[List of the Articles to be Presented]	
[Name of Article]	: Specification 1
[Name of Article]	: Drawing 1
[Name of Article]	: Abstract 1
[General Attorney Number]	: 9712823
[Necessity of Proof]	: Necessity

[Document name] Specification

[Title of the Invention] FURNACE FOR AND METHOD OF DRAWING AN OPTICAL FIBER

[Claims]

[Claim 1] A furnace for drawing an optical fiber, which furnace comprises a muffle tube and an inner tube connected to an end thereof, and in which an optical fiber preform supported at an upper portion thereof by a dummy rod is arranged in the muffle tube and the inner tube so as to be able to descend together with the dummy rod, and is heated and melted by a heater through the muffle tube to permit an optical fiber to be drawn from a lower end of the optical fiber preform, characterized in that a space above the optical fiber preform within the inner tube is partitioned into vertical portions at plural locations by one or plural sets of partitions disposed in the space, and gas blowing inlets, through which an inert gas is blown into the inner tube and the muffle tube, are provided on a wall surface of the inner tube below the partitions.

[Claim 2] The furnace for drawing an optical fiber, according to claim 1, wherein the partitions are composed of plural sets of partitions disposed with the dummy rod extending through the partitions, the plural sets of partitions descend downward in conformity to descent of the dummy rod, the plural sets of partitions are sequentially latched one by one from a topmost one in downward descent by the inner wall surface of the inner tube, and a space above the optical fiber preform within the inner tube is partitioned into vertical

portions by the latched partitions.

[Claim 3] The furnace for drawing an optical fiber, according to claim 2, wherein the plural sets of partitions are sequentially decreased in outer diameter from top to bottom, the inner tube is decreased in inner diameter from top to bottom to be in the form of a truncated cone, the plural sets of partitions descend downward in conformity to descent of the dummy rod, and the plural sets of partitions are sequentially latched one by one from a topmost one in downward descent by virtue of outer peripheral surfaces of the partitions coming into contact with the inner wall surface of the inner tube.

[Claim 4] The furnace for drawing an optical fiber, according to claim 3, wherein at least one set among the plural sets of partitions is composed of an outer member and an inner member, an outer diameter of the outer member is the same as an inner diameter of the inner tube in a location where the outer member is latched by the inner tube, a diameter of a central hole formed in the outer member is made larger than an outer diameter of the dummy rod, an outer diameter of the inner member is made larger than the diameter of the central hole of the outer member and smaller than the outer diameter of the outer member, a diameter of a central hole formed in the inner member is made a little larger than the outer diameter of the dummy rod, the dummy rod extends through the central holes with the outer member placed below and the inner member placed above, and the outer member holds the inner member when the outer member of the partitions is latched by the inner wall of the inner tube.

[Claim 5] The furnace for drawing an optical fiber, according to claim 1, wherein the partitions are composed of one or plural sets of partitions disposed near a lower end of the dummy rod or on an upper portion of the optical fiber proform in a manner to descend together with the optical fiber preform.

[Claim 6] The furnace for drawing an optical fiber, according to claim 5, wherein the one or plural sets of partitions comprise an outer member and an inner member, an outer diameter of the outer member is made smaller than an inner diameter of the inner tube, a diameter of a central hole formed in the outer member is made larger than an outer diameter of the dummy rod, an outer diameter of the inner member is made larger than the diameter of the central hole of the outer member and smaller than the outer diameter of the outer member, a diameter of a central hole formed in the inner member is made the same as or larger than the outer diameter of the dummy rod, the dummy rod extends through the central holes with the outer member placed below and the inner member placed above, the inner member is held by being placed on a supporting member fixed to the dummy rod or being fixed to the dummy rod, and the outer member is placed on the inner member.

[Claim 7] The furnace for drawing an optical fiber, according to any one of claims 1, 5 and 6, wherein outwardly facing protrusions are provided on an outer periphery of the partition so that a portion of the partition except the protrusions does not come into contact with the inner wall surface of the inner tube.

[Claim 8] A method of drawing an optical fiber, in which an optical fiber

preform supported at an upper portion thereof by a dummy rod is arranged in a muffle tube and an inner tube connected to an end thereof so as to be able to descend together with the dummy rod, and is heated and melted to permit an optical fiber to be drawn from the optical fiber preform, said method comprising arranging one or plural sets of partitions above the optical fiber preform within the inner tube, and heating and melting a lower end of the optical fiber preform and its neighborhood to draw an optical fiber from the lower end of the optical fiber preform while a space within the inner tube is partitioned into a plurality of vertical portions by the partitions and while an inert gas is blown into the inner tube and the muffle tube from gas blowing inlets provided on a wall surface of the inner tube below the partitions.

[Detailed Description of the invention]

[0001]

[Technical field of the invention]

The present invention relates to a furnace for and a method of heating and melting an optical fiber preform and drawing an optical fiber.

[0002]

[Prior art]

Various techniques have been known relating to a furnace for heating an optical fiber preform containing silica glass as its main component to draw an optical fiber, and are described in Japanese Patent No. 2542679 and Japanese Patent Laid-Open No. 147969/1993. Since drawings and terms used in these two prior arts are partly different from those used in the present

invention, they are changed in the following explanation into drawings and terms used in the description of the present invention for the sake of elucidating differences between the prior arts and the present invention.

[0003]

First, Fig. 7 shows an essential part of a furnace for drawing an optical fiber, described in Japanese Patent No. 2542679, and the reference numeral 21 denotes an optical fiber preform, 21a an optical fiber, 22 an inner tube, 22a gas blowing inlets, 23 an outer tube, 24 a gas supply port, 24a a gas passage, 25 a dummy rod, 25a a connection, 26 a retainer, 27 a seal piston, 28 a muffle tube, and 29 a heater.

[0004]

With the furnace for drawing an optical fiber, the dummy rod 25 and the optical fiber preform 21 are connected to each other by means of the connection 25a to descend downward together, and arranged in the muffle tube 28 and the inner tube 22 connected to an upper end of the muffle tube. A lower end of the optical fiber preform 21 and its vicinity are heated and melted by the heater 29 disposed outside the muffle tube 28, so that an optical fiber 21a is drawn downward from the lower end of the optical fiber preform 21. In addition, the inner tube 22 connected to the upper end of the muffle tube 28 serves to accommodate a lengthy optical fiber preform 21 at the beginning of the drawing.

[0005]

Also, the gas passage 24a is defined between the inner tube 22 and the

outer tube 23 disposed outside thereof so that an inert gas is supplied into the gas passage 24a from the gas supply port 24 to be blown into the inner tube 22 from a multiplicity of the gas blowing inlets 22a, which are provided on a wall surface of the inner tube 22 in heightwise and circumferential directions. The inert gas is caused to flow into the inner tube 22 and the muffle tube 28 for the purpose of preventing oxidizing deterioration of the muffle tube and so on. When heating causes the inert gas not to be uniform in temperature and flow, an optical fiber drawn from an optical fiber preform is liable to be varied in wire diameter.

[0006]

Hereupon, with this example of this optical fiber drawing furnace, a seal piston 27 is provided on the dummy rod 25 above the optical fiber preform 21 to be connected to the dummy rod 25 by the retainer 26 to be moved together with the dummy rod 25. At the start of wire drawing, the dummy rod 25 and the seal piston 27 are disposed upward since the optical fiber preform 21 is lengthy. As the drawing proceeds, the optical fiber preform 21 becomes short begining with a lower end thereof. As such shortening proceeds, the optical fiber preform 21 descends and so the dummy rod 25 and the seal piston 27 also descend.

[0007]

In this case, a space between the dummy rod 25 and the inner tube 22 would gradually increase if the seal piston 27 were not present. However, a space above the optical fiber preform 21 is substantially constant in volume due

to the presence of the seal piston 27. Thus, the provision of the seal piston 27 makes it hard for turbulence in flow to be generated in a space between the optical fiber preform 21 and the seal piston 27.

[0008]

Since a seal piston is used in this optical fiber drawing furnace, the seal piston itself needs a corresponding length and accordingly becomes heavy when an optical fiber preform becomes large-sized to have a length of 1.5 mm or longer. Accordingly, a supporting member, which supports these members in an upper area, must bear weights of the optical fiber preform and the seal piston and so becomes large-sized. Also, since the seal piston must resist high temperature to lead the necessity of using a heat resistant material such as carbon, quartz or the like, it is increased in cost when it becomes large-sized.

[0009]

Also, since the seal piston moves sliding on an inner wall surface of the inner tube, its sliding portion is liable to generate dust, by which strength of an optical fiber as drawn is in some cases adversely affected.

Also, as the seal piston descends, the multiplicity of gas blowing inlets provided on the wall surface of the inner tube are sequentially hidden and sealed by the seal piston begining with a topmost one, and so a precise controller for sequentially controlling a gas flow rate is necessary for maintaining a flow of the inert gas at a constant velocity of flow.

[0010]

Subsequently, an explanation will be given to an optical fiber drawing

furnace described in Japanese Patent Laid-Open No. 147969/1993. Fig. 8 shows an essential part of the optical fiber drawing furnace. In addition, the reference numerals in Fig. 8 as those in Fig. 7 denote the same members. Also, the reference numeral 22b denotes gas blowing inlets, 30 an upper lid, and 31 a partition. The optical fiber drawing furnace shown in Fig. 8 is different in the following points from that shown in Fig. 7. No member corresponding to the seal piston shown in Fig. 7 is present, and an upper end of an inner tube 22 is closed by the upper lid 30 except a location where the dummy rod 25 extends.

[0011]

Also, the gas blowing inlets 22b provided on a wall surface of the inner tube 22 are disposed on an upper portion of the inner tube 22, and the partition 31 for partitioning a space in the inner tube 22 into upper and lower portions is fixed to a portion near a lower end of the dummy rod 25 and below the gas blowing inlets. An inert gas having entered into the inner tube 22 from the gas blowing inlets 22b first enters into a space portion above the partition 31 and then flows around an optical fiber preform disposed below the partition through a gap between the partition 31 and the inner tube 22 or holes extending through the partition.

[0012]

With this optical fiber drawing furnace, a space above the partition becomes large as the optical fiber preform becomes short, so that the inert gas having left the gas blowing inlets once enters into a large space and a part of the inert gas is shut off at the partition to flow below the partition. Therefore, a

flow of the inert gas is liable to be turbulent in the space above the partition, which influences a space below the partition making it difficult to uniformly maintain a flow of of the inert gas around the optical fiber preform. Accordingly, although variation of an optical fiber in wire diameter can be suppressed to some extent, it is difficult to suppress such variation further.

[0013]

[Problems to be solved by the invention]

With the above-mentioned optical fiber drawing furnace of the prior art, in which a seal piston is provided, a supporting member therefor becomes large-sized because the seal piston is heavy in weight. Also, the installation cost is high. Further, there is caused a problem that an optical fiber is degraded in quality under the influence of dust generated due to sliding between the seal piston and the inner tube.

[0014]

Also, with an optical fiber drawing furnace, in which gas blowing inlets are provided on an upper portion of the inner tube and a partition is provided to be moved together with a dummy rod, an inert gas having entered from the gas blowing inlets once enters into a large space above the partition and then flows below the partition through near the partition or through holes, so that turbulence of a gas flow generated in the space above the partition is transferred to a space below the partition whereby a flow of the inert gas in a location where an optical fiber is drawn is susceptible to fluctuate. Therefore, it is difficult to suppress variation in wire diameter of an optical fiber to a

predetermined value or lower.The invention provides a furnace for and a method of drawing an optical fiber, by which the problems of the prior art are dissolved.

[0015]

[Means to solve the problem]

A furnace for drawing an optical fiber, according to the invention, is one, which comprises a muffle tube and an inner tube connected to an end thereof, and in which an optical fiber preform supported at an upper portion thereof by a dummy rod is arranged in the muffle tube and the inner tube so as to be able to descend together with the dummy rod, and is heated and melted from outside of the muffle tube by a heater to permit an optical fiber to be drawn from a lower end of the optical fiber preform, and in the furnace, a space above the optical fiber preform within the inner tube is partitioned into vertical portions at plural locations by one or plural sets of partitions disposed in the space, and gas blowing inlets, through which an inert gas is blown into the inner tube and the muffle tube, are provided on a wall surface of the inner tube below the partitions.

[0016]

The partitions are composed of plural sets of partitions disposed with the dummy rod extending through the partitions, the plural sets of partitions descend downward in conformity to descent of the dummy rod, the plural sets of partitions are sequentially latched one by one from a topmost one in downward descent by the inner wall surface of the inner tube, and a space

above the optical fiber preform within the inner tube is partitioned into vertical portions by the latched partitions. Thereby, even when the optical fiber preform becomes small with the progress of drawing and a space within the inner tube becomes large, flow of an inert gas within the inner tube can be made favorably stable since a space within the inner tube can be partitioned into a plurality of portions having suitable volumes by the respective sets of partitions.

[0017]

Also, the respective sets of partitions may comprise a single disk-shaped plate but can be composed of two plate-shaped members, that is, an outer member and an inner member. In this case, an outer diameter of the outer member is the same as an inner diameter of the inner tube in a location where the outer member is latched by the inner tube, and a diameter of a central hole formed in the outer member is made larger than an outer diameter of the dummy rod. Also, an outer diameter of the inner member is made larger than the diameter of the central hole of the outer member and smaller than the outer diameter of the outer member, and a diameter of a central hole formed in the inner member is made a little larger than the outer diameter of the dummy rod.

[0018]

When the dummy rod extends through the central holes of the outer member and the inner member with the inner member placed above and the outer member placed below, the outer member is supported by the inner wall of the inner tube whereby the inner member disposed above is placed and

supported on the outer member. In this manner, the respective sets of partitions comprise an outer member and an inner member, whereby even when the optical fiber preform swing to put the dummy rod in a state offset from a state concentric with the inner tube, the partitions will not injure the inner wall surface of the inner tube since the upper member slides on the lower member to move radially.

[0019]

Also, one or plural sets of partitions are arranged near a lower end of the dummy rod or on an upper portion of the optical fiber preform to be fixed to the dummy rod or the connection or the optical fiber preform whereby they can descend downward in conformity to descent of the dummy rod. In this case, the respective sets of partitions can be also composed of an outer member and an inner member. In this case, however, an outer diameter of the outer member is made smaller than an inner diameter of the inner tube, and a diameter of a central hole formed in the outer member is made larger than an outer diameter of the dummy rod. Also, an outer diameter of the inner member is made larger than the diameter of the central hole of the outer member and smaller than the outer diameter of the outer member. Also, a diameter of a central hole formed in the inner member is made the same as or larger than the outer diameter of the dummy rod.

[0020]

And the inner member is supported by the dummy rod or the connection with the outer member placed below and the inner member placed above. In

Also, Fig. 2(A) shows a state, in which an optical fiber preform is large at the start of drawing, and Fig. 2(B) shows a state, in which the optical fiber preform becomes small before the termination of drawing. In Figs. 1 and 2, the reference numeral 1 denotes an optical fiber preform, 1 an optical fiber, 2 a dummy rod, 3 a connection, 4 partitions, 5 and 5' an inner tube, 6 an outer tube, 7 gas supply ports, 7a a gas passage, 8 gas blowing inlets, 9 an upper lid, 10 a muffle tube, 11 a heater, and 12 a lower flue.